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LETTUCE INFECTIOUS YELLOWS VIRUS

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Florida leads in U. S. winter production of lettuce (Lactuca sativa L.), escarole and endive (Cichorium endivia L.). These members of the Compositae are produced predominantly in the muck soils which are located around the Everglades (80%), and also in Zellwood, Lake Placid and Sarasota. In addition, cantaloupe (Cucumis melo L.), cucumber (. sativus L.), spinach (Spinacia oleracea L.), summer squash (Cucurbita pepo L.), and watermelon (Citrullus lanatus Schrad.) are also important commercial vegetable crops in Florida. One or more of these crops are in production throughout the state at some time during the year.

FIGURE 1: Lettuce infectious yellows virus causing necrotic lesions at the leaf margins and a general yellowing of the leaves of field-grown iceberg lettuce *(Lactuca saliva* L.) DPI file #PP-450.

FIGURE 2: Lettuce infectious yellows virus causing yellows symptoms on field grown Crenshaw melon. DPI file #PP-451.

FIGURE *3:* *Bemisia tabaci* (sweet potato whitefly) adults and nymphs on a leaf. DPI file #PP-449.

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Lettuce infectious yellows virus (LIYV) of lettuce, cucurbits, (Figs. 1 & 2) and other vegetable crops was first recognized as a distinct viral pathogen in the irrigated desert vegetable production areas of the Southwestern USA (2,6) and Mexico (4) in the early 1980's. The severe losses (20-75%) caused by LIYV were associated with unprecedented increases in populations of Bemisia tabaci (Genn.), the sweet potato whitefly (Fig. 3) also known as cotton or tobacco whitefly (3,8,10,15). Although LIYV has not been detected in Florida, populations of B. tabaci have been increasing in Florida during the past several years (11). Economic damage in several crops including the silverleaf disorder in squash (20), irregular ripening in tomatoes (19), and geminiviruses associated with disease symptoms in tomatoes (17) are a direct result of the recent increases in B. tabaci populations in
Florida vegetables.

SYMPTOMS: Interveinal yellowing and/or reddening, and stunting of affected plants are characteristics of LIYV symptoms on a wide range of commercial and weed hosts (3,7,8). Infected lettuce leaves exhibit interveinal chlorosis (that develops into a general yellowing) and become brittle (3,8). Infected plants are usually stunted and, in head lettuce cultivars, compact heads fail to develop (3,8). Necrotic lesions appear at or near margins of older leaves as the disease progresses (3,16). In cucurbits, a splotchy mottle or interveinal chlorosis develops on mature leaves. This may be accompanied by vein-clearing, mild mosaic, subtle curling of the tips of young leaves, and a leathery texture in older leaves. Plants are stunted, exhibit poor fruit set and/or incomplete fruit development (3). Symptoms may appear as early as 3 weeks after plants emerge (16) or 10-12 days after inoculation.

DISEASE DEVELOPMENT: LIYV, a clostero-like virus with long flexous rods, is transmitted by B. tabaci but not by seed *or* by mechanical means (3,8,12,13). Several elements conducive to a LIYV disease epidemic (hosts susceptible to both B. tabaci and LIYV, the insect vector, and a suitable environment) are already present in Florida. Consequently, establishment of LIYV in Florida may result in heavy losses in lettuce, cucurbits and other susceptible crops.

Transmission efficiency of LIYV by the whitefly vector is greater than 66% when 5 or more viruliferous whiteflies feed on cheeseweed, Malva parviflora L. (8). The virus is considered to be transmitted in a semi-persistent manner because it maybe acquired in less than one hour by the whitefly vector, is subsequently transmitted within 6 hours, and the virus is retained in the insect for 3-4 days. Consequently, the availability of virus reservoir hosts (plants that are infected with the virus) figure prominently in the epidemiology of the disease.

The relationship between weed hosts for LIYV and virus epidemics is not completely understood (7,9,15). In the desert Southwest, the disease has occurred every year since 1981, despite the observation that population levels of B. tabaci may be lower and apparently few potential virus sources were available in some years. Also, field populations of B. tabaci in the Southwestern U. S. apparently do not reproduce on lettuce (1). Therefore, when epidemics occur, whitefly populations must originate from other virus infected crop plants or weed hosts that are present before or during the lettuce production season (3,8). Symptomatic weed hosts for LIYV include Chenopodium album L. and C. murale L. (lambsquarters), Ipomoea purpurea (L.) Lam. **(morning glory),** Lactuca serriola L. **(wild lettuce),** M. parviflora (cheeseweed), Portulaca oleracea L. **(purslane),** Rumex crispus L. **(dock),** Sonchus oleraceus L. **(sowthistle),** and Taraxacum officinale Weber **(dandelion),** among others (3,8). Cheeseweed is one weed host (others are suspected) where virus antigen is detectable but the plant does not show symptoms (4).

Whitefly associated disease problems could potentially occur in Florida since large whitefly populations have been recently documented on several host species which grow near virus susceptible crops. Whiteflies could subsequently disperse to virus-infected source plants (crops and/or weeds) and become viruliferous (able to carry and transmit the virus). A virus epidemic could become widespread as viruliferous whiteflies infest and transmit LIYV to susceptible crops. Some potentially important reproductive hosts of B. tabaci which are not susceptible to LIYV are Hibiscus esculentus L. (okra), Brassica oleracea Botrytis Group (broccoli), Capsicum annuum L. (pepper), Lycopersicon esculentum L. (tomato), and Sida spp. (sida).

DIAGNOSIS: The most reliable detection method is a time-consuming bioassay using B. tabaci to transmit the virus to indicator hosts (4,8). This is not practical since manipulation and management of virus-free whitefly colonies require resources and time beyond the budget of most diagnostic clinics. Nevertheless, this test could be useful in detecting LIYV when a mixture of viruses in a host mask symptoms typical of LIYV. A rapid, sensitive and economical diagnostic method is an enzyme-linked immunosorbent assay (indirect-ELISA, 4). This technique reliably detects LIYV when more mature symptomatic leaves are assayed. However, indirect-ELISA

does not always detect the virus in asymptomatic leaves of infected plants or from infected weeds that do not show symptoms (4). An improved ELISA which incorporates indirect-ELISA and a biotinylated secondary antibody has been developed (J. K. Brown, unpublished).

Detection of viral inclusion bodies, which are present as the virions become aggregated and comprise a major volume of the cell cytoplasm (12) is another reliable method. Inclusions appear red to violet when thin sections of root or young petiole tissue are placed in Azure stain (R. Christie, personal communication, 5). The extraction and analysis of ds-RNA (13) and the use of c-DNA probes (9) may also become more commonly used as these detection systems are perfected.

MANAGEMENT: Since LIYV is not currently found in Florida, the best control is to continue to exclude the virus from the state. This can be done by both the agricultural industry and the public assisting the Division of Plant Industry, FDACS, in preventing the casual introduction of this pathogen into the state. Integration of scouting, cultural and insecticidal control tactics is the best approach to managing the disease until biological control and host plant resistance can be developed for long term management (18). Resistance/tolerance to LIYV has been found in wild lettuce and efforts to transfer this trait to commercially acceptable varieties are underway (14,16).

Five cultural practices recommended to supplement insecticides in controlling whiteflies in Florida *are:* (1) Avoid establishing new crops susceptible to whiteflies in or near fields or greenhouses infested with whiteflies; (2) Screen transplant production houses to exclude whiteflies; (3) Remove volunteer crops and weeds which serve as whitefly hosts, from fields well in advance of the crops; (4) Scout plants for whiteflies; (5) Spray and destroy crop residues after harvest (18). Specific chemical control strategies may be obtained from the Cooperative Extension Service Office.

SURVEY AND DETECTION: LIYV affects a wide range of crop and weed hosts. Characteristic symptoms are interveinal yellowing or reddening, and stunting of affected plants. Diagnostic tests are most reliable when symptomatic tissue is used. Also, when possible, collect or make note of insects associated with symptoms. A survey of prominent weed species in and around fields will assist in determining management strategies.

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